Lithium-sulphur anode protection through ultra-stable organic layer

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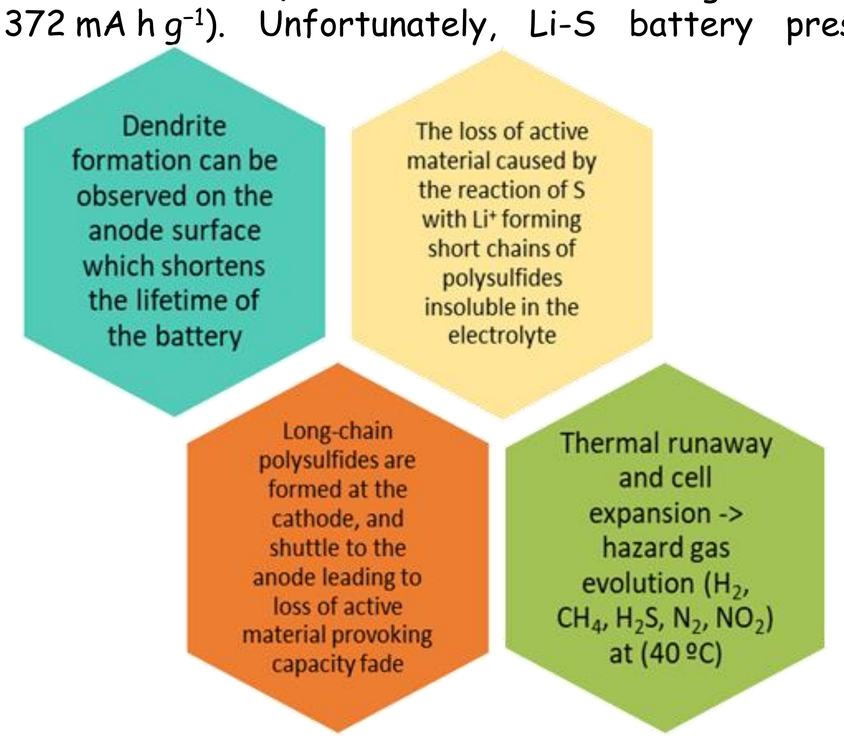
Introduction

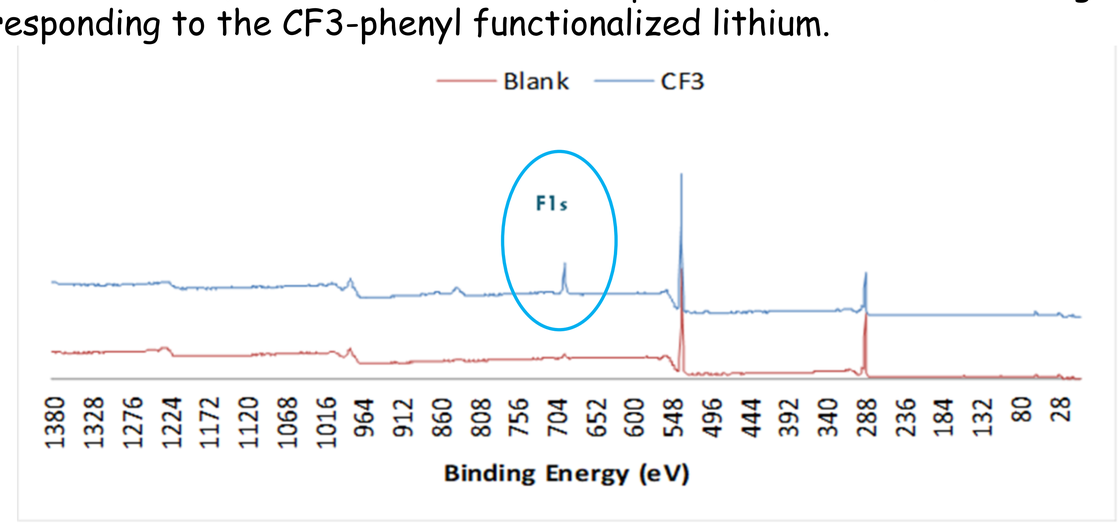
Development and improvement of different energy storage systems are required due to the growing energy demand from the past 50 years. Among this variety of systems, Lithium-Sulphur (Li-S) started to gain more importance thanks to its multi-electron conversion of sulphur on the cathode, leading to a theoretical capacity of 1672 mAh/g for the cathode, and 3860 mAh/g for the lithium anode (which is over ten times higher than the graphite one (LiC_6, 372 mA h g^{-1}). Unfortunately, Li-S battery presents several drawbacks:



Although so many options can be found in literature, the most promising one corresponds to an organic coating consisting in the stable immobilization (covalent character) on the metallic lithium anode of organic layers, enabling the minimization of the shuttle effect by preventing the diffusion of the polysulfide to the lithium surface (via electrostatic repulsion), and therefore the passivation of the electrode and the parasitic reaction with these anions during discharge.

Surface modification

XPS results show, after rinsed with multiple solvents in US, a strong F peak corresponding to the CF3-phenyl functionalized lithium.

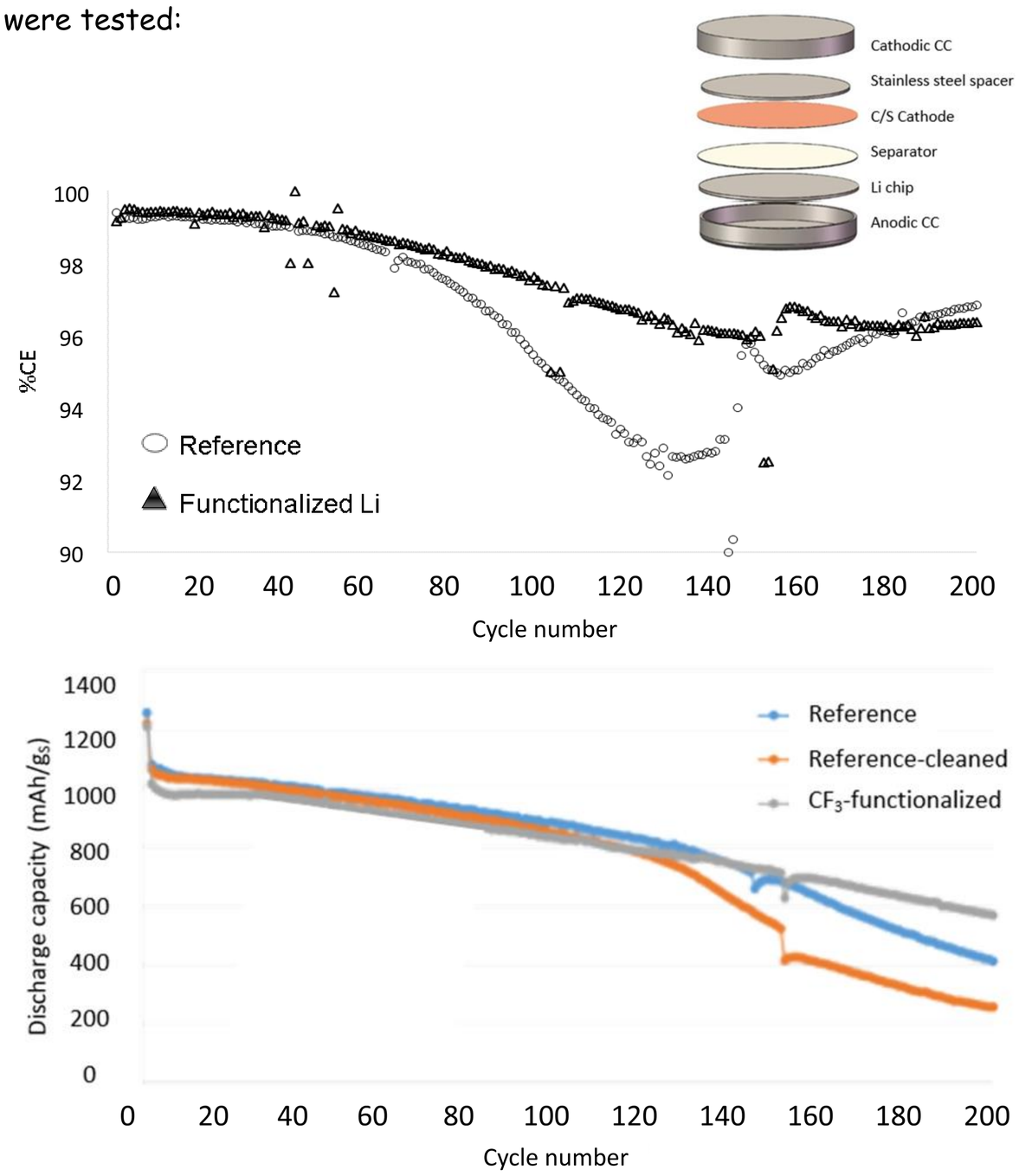


How?

Chemically or Electrochemically reduction of aryl diazonium salts, generated in situ, on the lithium surface providing a stable bond (covalent character) with new functional organic groups.

Lifetime, capacity and efficiency improvement in LiS battery

CR2016 cells where built with the functionalized lithium and batteries were tested:



Conclusions

Through this functionalization on lithium we are able of providing a covalent and stable bond with new functional groups on Li which is able of:

- Increase cycle life
- Reduce dendrite formation
- Reduce drop in coulombic efficiency
- Increase discharge capacity
- Enhance lithium plating
- Stop PS diffusion

Next steps

New functionalization groups are being tried

Pouch cell system is being built

Up-scaling methods are being investigated

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